

FORM PTO-1390  
REV. 5-93U.S. DEPARTMENT OF COMMERCE  
PATENT AND TRADEMARK OFFICE

ATTORNEYS DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371**

P-00,1260

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)

**09/581712**

INTERNATIONAL APPLICATION NO.

INTERNATIONAL FILING DATE

PRIORITY DATE CLAIMED

PCT/DE98/03621

9 December 1998

16 December 1997

TITLE OF INVENTION "DEVICE FOR COOLING ELECTRICAL SUBASSEMBLIES"

APPLICANT(S) FOR DO/EO/US Guido Reeck, Bruno Hoefer and Alfred Gahse

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay.
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ has been transmitted by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3))
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

**Items 11. to 16. below concern other document(s) or information included:**

11. ☒ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98; (PTO 1449, Prior Art, Search Report).
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.  
☒ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
  - a. ☒ Submission of Drawings - 6 sheets
  - b. ☒ Submission of Drawings Including Translations of the German-Language Legends - 6 sheets
  - b. ☒ EXPRESS MAIL #EL544622081US dated June 16, 2000

09/581712

PCT/DE98/03621

17. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5):**

Search Report has been prepared by the EPO or JPO ..... \$840.00

International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) ... \$670.00

No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2)) ..... \$760.00

Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO ..... \$970.00

International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) ..... \$ 96.00

**ENTER APPROPRIATE BASIC FEE AMOUNT =**

CALCULATIONS

PTO USE ONLY

\$ 840.00

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).

\$

Claims

Number Filed

Number  
Extra

Rate

Total Claims

16 - 20 =

0

X \$18.00

\$

Independent Claims

2 - 3 =

0

X \$ 78.00

\$

Multiple Dependent Claims

\$260.00 +

\$

**TOTAL OF ABOVE CALCULATIONS =**

\$ 840.00

Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28)

\$

**SUBTOTAL =**

\$ 840.00

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).

\$

**TOTAL NATIONAL FEE =**

\$ 840.00

Fee for recording the enclosed assignment (37 C.F.R. 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). \$40.00 per property

+

**SEE  
ATTACHED  
ENVELOPE****TOTAL FEES ENCLOSED =**

\$ 840.00

Amount to be  
refunded

\$

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\$

a. ☒ A check in the amount of \$840.00 to cover the above fees is enclosed.b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_ to cover the above fees. A duplicate copy of this sheet is enclosed.c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 08-2290. A duplicate copy of this sheet is enclosed.**NOTE:** Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.**SEND ALL CORRESPONDENCE TO:**Hill & Simpson  
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SIGNATURE

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NAME

24,149

Registration Number

09/581712

534 Rec'd PCT/PTO 16 JUN 2000

- 1 -

**IN THE UNITED STATES ELECTED OFFICE OF  
THE UNITED STATES PATENT AND TRADEMARK OFFICE  
UNDER THE PATENT COOPERATION TREATY - CHAPTER II**

**PRELIMINARY AMENDMENT**

5      APPLICANTS:      Guido Reeck, Bruno Hofer and Alfred Gahse

ATTORNEY

DOCKET NO.:      P-00,1260

SERIAL NO.:

EXAMINER:

FILING DATE:

ART UNIT:

10      INTERNATIONAL APPLICATION NO.: PCT/DE98/03621

INTERNATIONAL FILING DATE: 9 December 1998

INVENTION: "DEVICE FOR COOLING ELECTRICAL SUBASSEMBLIES"

**BOX PCT**

Assistant Commissioner for Patents

15      Washington, D.C. 20231

S I R:

Please amend the above-identified International Application before entry into the National Stage before the U.S. Patent and Trademark Office under 35 USC 371 as follows:

20      **IN THE SPECIFICATION:**

Page 1, lines 1-3, please replace these lines with the following headings and title:

TITLE

"A COOLING DEVICE FOR ELECTRICAL SUBASSEMBLIES"

25

BACKGROUND OF THE INVENTION--;

09581712 101500

line 28, before "above" insert --and--; and  
line 29, change "being" to read --is--.

Page 2, line 34, after "modules etc." insert the following heading:  
--SUMMARY OF THE INVENTION--.

5           Page 3, line 2, change "housing" to read --housing--  
            lines 3 and 4, please delete these lines; and  
            line 11, after "up" insert --or create--.

Page 5, line 22, replace the line with the following line and heading:  
--drawings.

10           BRIEF DESCRIPTION OF THE DRAWINGS--;  
            lines 24 and 28, before "front" (each occurrence) insert  
            --diagrammatic--;  
            line 32, before "side" insert --diagrammatic--; and  
            line 35, delete "and".

15           Page 6, line 1, before "side" insert --diagrammatic--;  
            line 6, after "shows" insert --a diagrammatic side view of--;  
            line 11, after "shows" insert --a diagrammatic side view of--;  
            line 14, after "arrangement." insert the following heading:  
            --DESCRIPTION OF THE PREFERRED EMBODIMENTS--;  
20           line 17, change "art according to" to read --art device of--;  
            line 23, change "V" to read --VI-V4--;  
            lines 25-27, change these lines to read --circuits with one being an  
            external circuit having an air flow identified by white arrows and an internal

or second cooling circuit having an air flow identified by black arrows. The two cooling circuits are--; and  
line 28, delete "being".

Page 7, line 3, before "located" insert --which is--;

5 line 23, change "disadvantages," to read --already mentioned disadvantages--;

line 24, please delete this line;

line 25, delete "description,";

10 line 28, change "circuits, the" to read --circuits. The--; and  
line 29, change "being" to read --is--.

Page 8, line 17, change "(not illustrated)" to read --(see Fig. 3)--.

Page 10, line 2, before "flowing" insert --from--.

Page 13, line 1, change "Patent Claims" to read --WE CLAIM:--.

15 and  
Page 15, line 2, delete "Arrangement for cooling electrical subassemblies";  
line 15, delete "FIG 3".

**IN THE CLAIMS:**

Please amend claim 1 to read as follows:

20 --1. (Amended) An arrangement for cooling electrical subassemblies [(BG)]  
arranged in a housing [(G)], said arrangement having [-] at least one water-repellent

membrane filter [(MB, in each case] arranged in an air inlet [(LE)] of the housing [(G),] for the surface filtration of dirt particles from cooling air flowing [in] into the housing for cooling the electrical subassemblies [(BG)], and [-] at least one cooling device [(VE)] to build up an airflow in the housing [(G)] and to lead the filtered cooling air, which is heated up because of flowing through the subassemblies [(BG)], out of the housing [(G)] through at least one air outlet [(LA)].--

Claim 2, line 1, change "having" to read --which includes--;  
line 2, change "(LLE)," to read --being--;  
line 4, delete "(BG),"; and  
line 5, delete "(BG)".

Claim 3, line 1, delete "a preceding";  
line 2, change ", having" to read --1, which includes--;  
same line, delete "(LLE),"; and  
line 4, delete "(BG)," and "(BG)".

Claim 4, line 1, delete "a preceding";  
line 2, change ", having" to read --1, which includes--; and  
line 3, delete "(VE)".

Claim 5, line 1, delete "the preceding";  
line 2, change ", having" to read --4, which includes--;  
same line, delete "(ST)";  
line 3, delete "(VE)"; and  
line 5, delete "(G)".

Claim 6, line 1, delete "the preceding";  
line 2, change ", in which" to read --5, wherein--;  
same line, delete "(ST)";  
line 3, delete "(VE)";  
5 line 4, delete "(G)";  
line 5, delete "(LA)"; and  
lines 6 and 7, delete "(MB)" (both occurrences).

Claim 7, line 1, delete "a preceding";  
line 2, change ", in which" to read --1, wherein--;  
10 same line, delete "(LE)";  
line 3, delete "(G)"; and  
line 5, delete "(BG)".

Claim 8, lines 1 and 2, change "one of the preceding claims, in which" to  
read --claim 1, wherein--;  
15 line 2, delete "(LA)"; and  
line 5, delete "(G)".

Please cancel claim 9, without prejudice, and substitute the following  
claims:

--10. A base station for a system selected from a mobile telephone system  
20 and an access network system, said base station having a housing containing  
electrical subassemblies, said housing having at least one air inlet and at least one air  
outlet, and an arrangement for cooling the electrical subassemblies, said arrangement  
comprising at least one water-repellant membrane filter being arranged in each air

inlet of the housing for the surface filtration of dirt particles from the cooling air flowing in the inlet, and at least one cooling device to create an airflow in the housing to lead the filtered cool air, after being heated up because of flowing through the subassemblies, out of the air outlet.--

5           --11. A base station according to claim 10, which includes an air guide device being arranged respectively adjacent each electrical subassembly to guide the filtered cooling air through one subassembly in each case.--

10           --12. A base station according to claim 10, which includes an air guide device being arranged adjacent each electrical subassembly to shield the subassembly.--

          --13. A base station according to claim 10, which includes a motor-driven fan wheel as the cooling device.--

15           --14. A base station according to claim 13, which includes a control device to control a motor speed of the motor-driven fan wheel as a function of the temperature in the interior of the housing and the temperature of the cooling air flowing into the inlet.--

20           --15. A base station according to claim 14, wherein the control device controls the cooling device in such a way that the direction of the airflow in the housing can be reversed so that cooling airflow in through the air outlet is directed through the membrane filter to free the filter of deposited dirt particles.--



--16. A base station according to claim 10, wherein the air inlet is arranged in an area adjacent the bottom area of the housing so that the cooling air flowing in through the inlet acts on the underside of the subassemblies.--

5 --17. A base station according to claim 10, wherein the air outlet is arranged in an upper region of the housing.--

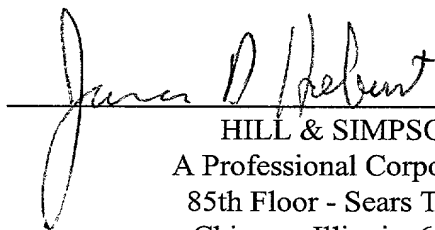
**REMARKS**

Claims 1-8 and 10-17 are presented for examination.

10 By this amendment, the specification has been amended to add headings and to correct grammatical and typographical errors; claims 1-8 have been amended to overcome possible incorrect multiple-dependency and claim 9 has been cancelled and replaced by claims 10-17.

It is respectfully submitted that the amendments to the claims do not change the allowable subject matter found in the Preliminary Examination Report of October 12, 1999.

15 Respectfully submitted,

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20 DATED: June 16, 2000

INTERNATIONALE ANMELDUNG VERÖFFENTLICHT NACH DEM VERTRAG ÜBER DIE  
INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT)

(51) Internationale Patentklassifikation <sup>6</sup> : <b>H05K 7/20</b>	<b>A1</b>	(11) Internationale Veröffentlichungsnummer: <b>WO 99/31947</b>  (43) Internationales Veröffentlichungsdatum: 24. Juni 1999 (24.06.99)
<p>(21) Internationales Aktenzeichen: PCT/DE98/03621</p> <p>(22) Internationales Anmeldedatum: 9. Dezember 1998 (09.12.98)</p> <p>(30) Prioritätsdaten: 197 55 944.1 16. Dezember 1997 (16.12.97) DE</p> <p>(71) Anmelder (für alle Bestimmungsstaaten ausser US): SIEMENS AKTIENGESELLSCHAFT [DE/DE]; Wittelsbacherplatz 2, D-80333 München (DE).</p> <p>(72) Erfinder; und (75) Erfinder/Anmelder (nur für US): REECK, Guido [DE/DE]; Isartalstrasse 32, D-80469 München (DE). HOEFER, Bruno [DE/DE]; Neufeldstrasse 11a, D-82140 Olching (DE).</p> <p>(74) Gemeinsamer Vertreter: SIEMENS AKTIENGESELLSCHAFT; Postfach 22 16 34, D-80506 München (DE).</p>		<p>(81) Bestimmungsstaaten: AU, BR, CN, ID, IL, IN, JP, KR, MX, PL, SG, TR, UA, US, VN, ARIPO Patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), eurasisches Patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), europäisches Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI Patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p><b>Veröffentlicht</b> <i>Mit internationalem Recherchenbericht. Vor Ablauf der für Änderungen der Ansprüche zugelassenen Frist; Veröffentlichung wird wiederholt falls Änderungen eintreffen.</i></p>

(54) Title: DEVICE FOR COOLING ELECTRICAL SUBASSEMBLIES

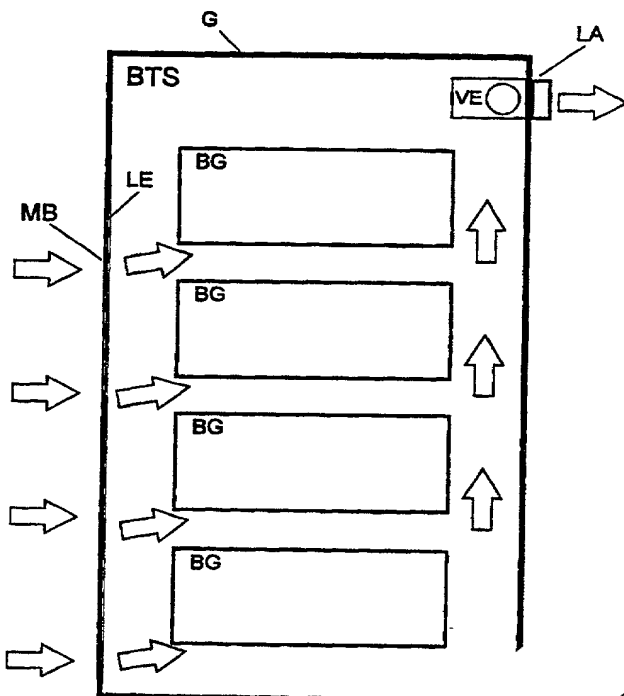
(54) Bezeichnung: ANORDNUNG ZUM KÜHLEN VON ELEKTRISCHEN BAUGRUPPEN

## (57) Abstract

The invention relates to a device for cooling electrical sub-assemblies which are located in a housing, for use especially in base stations of a mobile telecommunications system or an access network system. The inventive device has at least one hydrophobic membrane filter for surface-filtering particles of dirt from an incoming stream of cooling air for cooling the electrical sub-assemblies, each of said filters being situated in an air inlet of the housing. The device also has at least one cooling device for building up a flow of air and for guiding the filtered cooling air out of the housing through at least one air outlet, said air having been heated by its passage through the electrical sub-assemblies.

## (57) Zusammenfassung

Die Erfindung betrifft eine Anordnung zum Kühlen von in einem Gehäuse angeordneten elektrischen Baugruppen, insbesondere für eine Verwendung in Basisstationen eines Mobilfunksystems oder Access-Network-Systems. Die Anordnung weist zumindest einen in jeweils einem Lufteinlass des Gehäuses angeordneten wasserabweisenden Membranfilter für eine Oberflächenfilterung von Schmutzpartikeln aus einströmender Kühlluft zum Kühlen von elektrischen Baugruppen sowie zumindest eine Kühleinrichtung zum Aufbau einer Luftströmung und zum Herausführen der gefilterten, aufgrund eines Durchströmens der Baugruppen erwärmten, Kühlluft durch zumindest einen Luftauslass aus dem Gehäuse auf.



Seitenansicht

SIDE VIEW

GR 97 P 6458 - Version for foreign countries

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## Description

## Arrangement for cooling electrical subassemblies

5           The invention relates to an arrangement for cooling electrical subassemblies arranged in a housing, in particular for use in base stations of a mobile radio system or access network system.

10           During operation, technical devices produce waste heat, which leads to the device heating up. Since a technical device can ensure its functionality only within a restricted temperature range, arrangements for cooling this device are normally provided.

15           In electrically operated devices, the power loss of components and subassemblies through which current flows leads to heating. If such technical devices are not installed in protected, temperature-controlled rooms, during operation attention must be paid not only to the permissible temperature range of the electrical subassemblies but, at the same time, also to the possible temperature range of the environment of the technical device. Both temperature ranges have to be taken into account when dimensioning the arrangement for cooling. Standard components for a technical device have, for example, a permissible operating temperature range of from 0 to 70°C. Components of this type are used, for example, in base stations of a mobile radio system or access network system, but also in other technical devices, such as traffic control devices or supply devices. Moreover, adequate protection from dirt particles and penetrating moisture must be ensured for the electrical components and subassemblies, above all when they are used outside closed rooms, it being necessary to comply with the protection regulations in accordance with the specified IP classes.

In base stations according to the prior art, such as is disclosed, for example, by the earlier German patent application 19626778.1, the problem of cooling the electrical components and subassemblies, with simultaneous protection from dirt and moisture, beginning from a specific IP class, is solved by using two cooling circuits separated by an air/air heat exchanger. In this arrangement, the atmosphere and the air stream produced by one or more fans in the interior of the base station are separated completely from the external ambient atmosphere. However, the complicated construction of the base station, containing two cooling circuits, has a detrimental effect on the costs, the volume and the weight of the base station. This construction also has the disadvantage that the cooling arrangement only operates at and above a specific temperature drop between the atmosphere in the interior of the base station and the ambient atmosphere, as a result of which the temperature in the interior is always above the temperature of the ambient atmosphere. In this case, under certain circumstances it may occur that the upper limiting temperature (for example 70°C) of individual components or subassemblies is exceeded if the temperature of the ambient atmosphere exceeds the corresponding limiting temperatures. In general, it is true that: ambient temperature + heat-exchanger temperature difference  $\Delta T$  + internal heating  $\leq$  component limiting temperature (e.g. 70°C). In order to reduce the temperature difference  $\Delta T$  needed for the cooling, a higher technical outlay is needed with a simultaneous increase in the volume of the base station or, alternatively, the use of so-called active cooling devices such as compressors, Peltier modules etc.

The invention is therefore based on the object of providing an arrangement for cooling which circumvents the above-described disadvantages of the arrangements according to the prior art.



prevents the penetration of dirt particles into the filter and thus permits simple cleaning.

In a first refinement, the arrangement according to the invention has air guide devices, respectively underneath and/or above the electrical subassemblies, to guide the filtered cooling air flowing in through one subassembly in each case and/or to shield the electrical subassemblies. These air guide devices advantageously achieve a homogenous distribution of the cooling air flowing in over the base surface of the respective electrical subassemblies, and thus the uniform cooling of the electrical subassemblies.

According to further refinements of the invention, the cooling device comprises a motor-driven fan wheel, the motor speed and thus the throughput of cooling air in the housing in addition being controlled by a control device as a function of the temperature in the housing and/or of the temperature of the ambient atmosphere, and thus of the temperature of the cooling air flowing in. By this means, for example, a constant operating temperature of the electrical subassemblies, and a constant temperature in the interior of the housing, can be ensured, and therefore the service life of the electrical subassemblies can advantageously be prolonged. Furthermore, the speed of the cooling device can in each case be controlled in such a way that the permissible limiting temperatures of the electrical subassemblies are just not exceeded, and the noise emission of the arrangement is minimized by the lowest possible speed of the cooling device.

Furthermore, by means of an appropriately configured cooling device, the direction of the airflow in the housing can be reversed, so that cooling air flows into the housing through the air outlet and is led out through the membrane filter,

by which means dirt particles deposited on the surface of the membrane filter are advantageously removed.

According to a further refinement, the air inlet is arranged in the side and/or bottom area of the housing in such a way that the cooling air flowing in acts on the undersides of the subassemblies and therefore a flow through the subassemblies is advantageously made possible by the cooling air heated by flowing through the electrical subassemblies being sucked up by the cooling device and being led out through at least one air outlet arranged in the upper and/or side area of the housing.

The arrangement according to the invention is suitable, in particular, for use in base stations or similar outdoor installations of a mobile radio system or access network system, as well as in comparable technical devices such as traffic control devices, directional radio devices and the like, which have to be operational within a wide temperature range.

Exemplary embodiments of the invention will be explained in more detail with reference to the appended drawings, in which:

FIG 1 shows a front view of a base station of a mobile radio system having a cooling arrangement according to the prior art,

FIG 2 shows a front view of an exemplary base station having the arrangement according to the invention for cooling electrical subassemblies,

FIG 3 shows a side view of an exemplary base station having an arrangement according to the invention for cooling electrical subassemblies, and

FIG 4 shows a side view of an exemplary base station having an arrangement according to the invention for cooling electrical subassemblies with additional features,

FIG 5 shows an exemplary base station having an arrangement according to the invention for cooling electrical subassemblies with a number of cooling devices,

FIG 6 shows an exemplary base station having an arrangement according to the invention for cooling electrical subassemblies with a number of cooling devices in a modified arrangement.

The base station BTS, for example a mobile radio system according to the prior art according to FIG 1, contains a number of electrical subassemblies BG. During the operation of the base station BTS, the power loss of the individual electrical subassemblies BG leads to heating, which gives rise to the necessity for cooling. The cooling is carried out by cooling devices V incorporated in a number of cooling circuits.

These cooling circuits are two cooling circuits, each identified by black and white arrows and separated from each other in each case, an external and an internal cooling circuit, the two cooling circuits being separated from each other by an air/air heat exchanger WT.

The external cooling circuit is implemented by two cooling devices V1 and V2. Air at the temperature of the ambient atmosphere is sucked into the base station BTS by the first cooling device V1 through an air inlet LE on one side of the base station BTS. The air is heated in the heat exchanger WT and is subsequently forced out by the second cooling device V2 from an air outlet LA on the opposite side of the base station BTS. This external



cooling circuit extends, for example according to FIG 1, in the vertical direction.

The second cooling circuit, located in the interior of the base station BTS, extends through the heat exchanger WT in the horizontal direction. Here, two further cooling devices V3 and V4 implement the internal cooling circuit. Warm air is sucked out of the subassemblies BG into the heat exchanger WT by the third cooling device V3. The warm air passes over the plates or ribs of the heat exchanger WT and, in so doing, gives up heat energy to these cooling plates or ribs and ultimately to the external cooling circuit. The fourth cooling device V4 in turn forces the cooled air into the subassemblies BG.

This divided cooling circuit carries the heat produced in the interior of the base station BTS away to the ambient atmosphere of the base station BTS. The cooling devices V1 to V4 used are generally known ventilators, since air exchange on the basis of natural convection is inadequate because of the considerable heating of the subassemblies.

The construction of the base station BTS with a divided cooling circuit leads to the disadvantages, already mentioned in the introduction to the description, of high technical outlay, high costs, high weight, large volume and a necessary temperature difference  $\Delta T$ , which occurs disadvantageously, between the internal and external cooling circuits, the internal circuit always being warmer by  $\Delta T$  than the cooling external circuit.

FIG 2 illustrates, likewise in a front view, a base station BTS having electrical subassemblies BG arranged as in the base station BTS according to the prior art. A membrane filter MB is arranged in an air inlet LE provided on the front of the housing G of the base station BTS,

the air inlet LE being of such a size that cooling air flowing in through the membrane filter MB from the ambient atmosphere of the base station BTS can flow through the electrical subassemblies BG, in each case from below and, if appropriate, from the front, and thus effects the cooling of the subassemblies. The active area of the membrane filter MB, which, for example by means of forming folds, can be greater than the air inlet LE, is dimensioned such that the pressure drop of the cooling air flowing in through the cooling device VE can be compensated for or, in spite of the membrane filter MB being partly made up by dirt particles, sufficient cooling air can still flow in. A cooling arrangement VE arranged in the upper area of the housing G sucks up the cooling air heated as it flows through and around the electrical subassemblies BG, and carries it away to the ambient atmosphere through an air outlet LA (not illustrated).

FIG 3 illustrates a side view of the base station BTS described in FIG 2, in order to illustrate the exemplary internal construction in more detail. On the left-hand side of the housing G of the base station BTS, the membrane filter MB is arranged in the air inlet LE. The membrane filter MB is designed, for example, as a surface filter, which has the particularly advantageous property of separating dirt particles and water or moisture from the ambient atmosphere as early as at the surface of the membrane, by which means, for example, sensitive electronic modules or circuits in the subassemblies BG can be protected against such environmental influences. By means of special designs of the membrane filter MB, protection regulations following the IP guidelines up to IP55, for example, can be satisfied. Furthermore, the cooling of the subassemblies by causing cooling air to flow through the housing G has the direct advantage of a necessary temperature difference  $\Delta T$  tending to zero between the temperature of the ambient atmosphere and thus the temperature of the cooling air flowing in

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device VE. This arrangement advantageously prevents cooling air which has already been heated flowing through one or more further subassemblies BG, and prevents any temperature peak occurring in some subassemblies BG. Furthermore, the air guide devices LLE can be used for the mutual shielding of the subassemblies BG from the point of view of satisfying protection regulations relating to electrical magnetic radiation.

10 In order to regulate the temperature in the interior of the housing G, the speed of the electric motor of the cooling device VE is controlled by a control device ST. In order to register parameters for this control, temperature sensors can be provided, for example in the area of the air inlet LE and at various points within the housing G, said sensors continuously determining the temperatures of the cooling air flowing in and of the atmosphere in the interior of the housing G. In this regulation system, the throughput of cooling air in the housing G is varied via the speed of the electric motor of the cooling device VE, in order, for example, to maintain a constant temperature in the interior of the housing G irrespective of the temperature of the ambient atmosphere. A constant operating temperature of the subassemblies BG has, for example, a positive effect on the operating lifetime of the electronic components and of the high-power circuits. In addition, keeping the speed of the cooling device VE constantly low, under the condition that the limiting temperature of +70°C is not exceeded, permits the noise emission from the base station BTS to be minimized. Furthermore, in the case of a cold start of the base station BTS, the regulation system can refrain from operating the cooling device VE at the start, in order to permit the subassemblies to heat up rapidly to the desired operating temperature, and only to carry out further regulation of the speed of the cooling

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- 10a -

device VE to maintain the operating temperature after this operating temperature has been reached.

During a cold start, or else manually during maintenance of the base station BTS, the airflow in the housing can be reversed, for example by changing the position of the vanes of the fan wheel of the cooling devices VE, as a result of which cooling air flows into the housing G through the air outlet LA, and is led out through the membrane filter MB. In the process, dirt particles deposited on the surface of the membrane filter MB are detached, and cleaning of the membrane filter MB is therefore achieved. This cleaning operation can, for example, also be initiated by means of a continuous measurement of the air throughput as a function of the speed of the cooling arrangement VE, being initiated when a throughput falls below a permanently defined value, the measured ratio indicating the degree of soiling of the membrane filter MB.

FIG 5 shows a base station BTS in which, differing from the base station BTS in FIG 4, a cooling device VE having an air outlet LA in each case is respectively arranged above each electrical subassembly BG. The cooling air heated by flowing through the subassembly BG is led directly to the cooling devices VE by the air guide device LLE respectively arranged above a subassembly BG. This arrangement provides the advantage that, in the event of any possible failure of a cooling devices VE, and the switching off of the respective subassembly BG needed as a result because of the risk of overheating, all the further subassemblies BG can continue to remain in operation. Therefore, in this case the operation of the major part of the receiving paths or transmitting paths of the base station BTS can be ensured by the subassemblies BG set up in parallel for each path. For the area which the base station BTS supplies, the result is only an insignificant restriction on the performance capacity by comparison with complete failure of the base station

BTS in the event of a malfunction of the individual cooling arrangement VE according to FIGS 2, 3 and 4.



FIG 6 shows a further embodiment of the arrangement according to the invention in a base station BTS. In this embodiment, the air inlet LE and, correspondingly, the membrane filter MB are arranged on the underside of the housing G of the base station, as a result of which the cooling air flowing in acts directly on the undersides of the subassemblies BG. Cooling devices VE in each case arranged above the subassemblies BG build up an airflow. The cooling air heated as a result of flowing through the respective subassembly BG is fed directly to the cooling device VE by an air guide devices LLE of funnel-like design. The cooling air thus flows successively through all the subassemblies in the form of a series cooling system, and is led out at an air outlet LA arranged above the top subassemblies BG.

Otherwise, both the air inlet LE and the respective air outlet LA can be arranged on any side of the housing G of the base station BTS.

Patent claims

1. An arrangement for cooling electrical subassemblies (BG) arranged in a housing (G), having
  - 5 - at least one water-repellent membrane filter (MB), in each case arranged in an air inlet (LE) of the housing (G), for the surface filtration of dirt particles from cooling air flowing in for cooling the electrical subassemblies (BG), and
  - 10 - at least one cooling device (VE) to build up an airflow in the housing (G) and to lead the filtered cooling air, heated up because of flowing through the subassemblies (BG), out of the housing (G) through at least one air outlet (LA).
- 15 2. The arrangement as claimed in claim 1, having an air guide device (LLE), arranged respectively underneath and/or above the electrical subassemblies (BG), to guide the filtered cooling air through one subassembly (BG) in each case.
- 20 3. The arrangement as claimed in a preceding claim, having an air guide device (LLE), arranged respectively underneath and/or above the electrical subassemblies (BG), to shield the subassembly (BG).
4. The arrangement as claimed in a preceding  
25 claim, having a motor-driven fan wheel as the cooling device (VE).
5. The arrangement as claimed in the preceding claim, having a control device (ST) to control the motor speed of the cooling device (VE) as a function of  
30 the temperature

in the interior of the housing (G) and/or of the temperature of the cooling air flowing in.

6. The arrangement as claimed in the preceding claim, in which the control device (ST) controls the cooling device (VE) in such a way that the direction of the air flow in the housing (G) is reversed, so that cooling airflows in through the air outlet (LA) and is led out through the membrane filter (MB), the membrane filter (MB) being freed of deposited dirt particles by the cooling air flowing out.

7. The arrangement as claimed in a preceding claim, in which the air inlet (LE) is arranged in the side and/or bottom area of the housing (G) in such a way that the cooling air flowing in acts on the undersides of the subassemblies (BG).

8. The arrangement as claimed in one of the preceding claims, in which the air outlet (LA) for leading the filtered and heated cooling air out is arranged in the upper and/or side area of the housing (G).

9. A base station (BTS) of a mobile radio system or of an access network system, having an arrangement for cooling as claimed in one of claims 1 to 8.

## Abstract

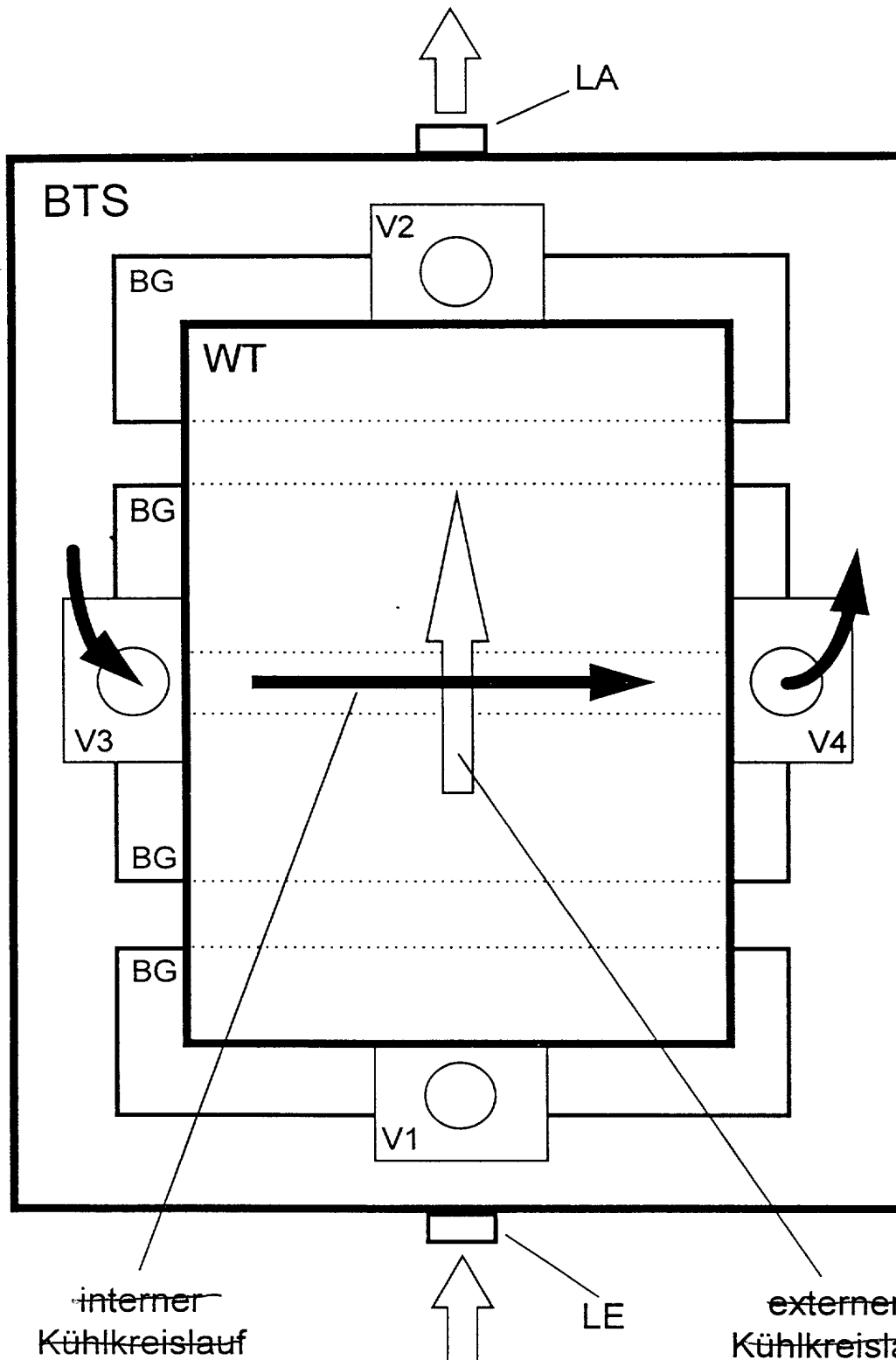
# Arrangement for cooling electrical subassemblies

The invention relates to an arrangement for cooling electrical subassemblies arranged in a housing, in particular for use in base stations of a mobile radio system or access network system. The arrangement has at least one water-repellent membrane filter, in each case arranged in an air inlet of the housing, for the surface filtration of dirt particles from cooling air flowing in for cooling electrical subassemblies, as well as at least one cooling device to build up an airflow and to lead the filtered cooling air, heated because of flowing through the subassemblies, out of the housing through at least one air outlet.

FIG 3

1/6

(PRIOR ART)  
 FIG 1 ~~(Stand der Technik)~~

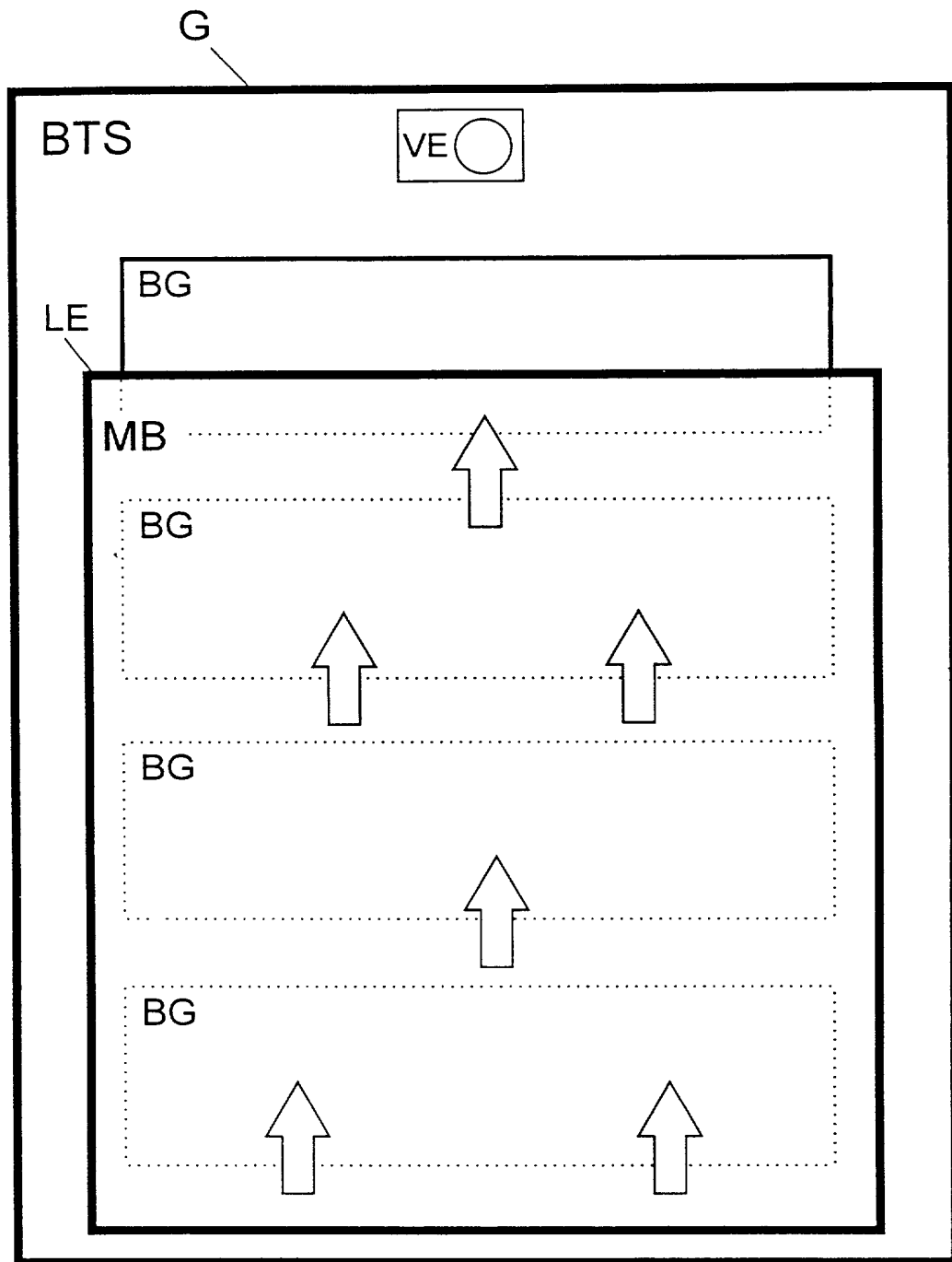


interner  
 Kühlkreislauf  
 Internal  
 Cooling Circuit

Vorderansicht  
 Front View

externer  
 Kühlkreislauf  
 External  
 Cooling Circuit

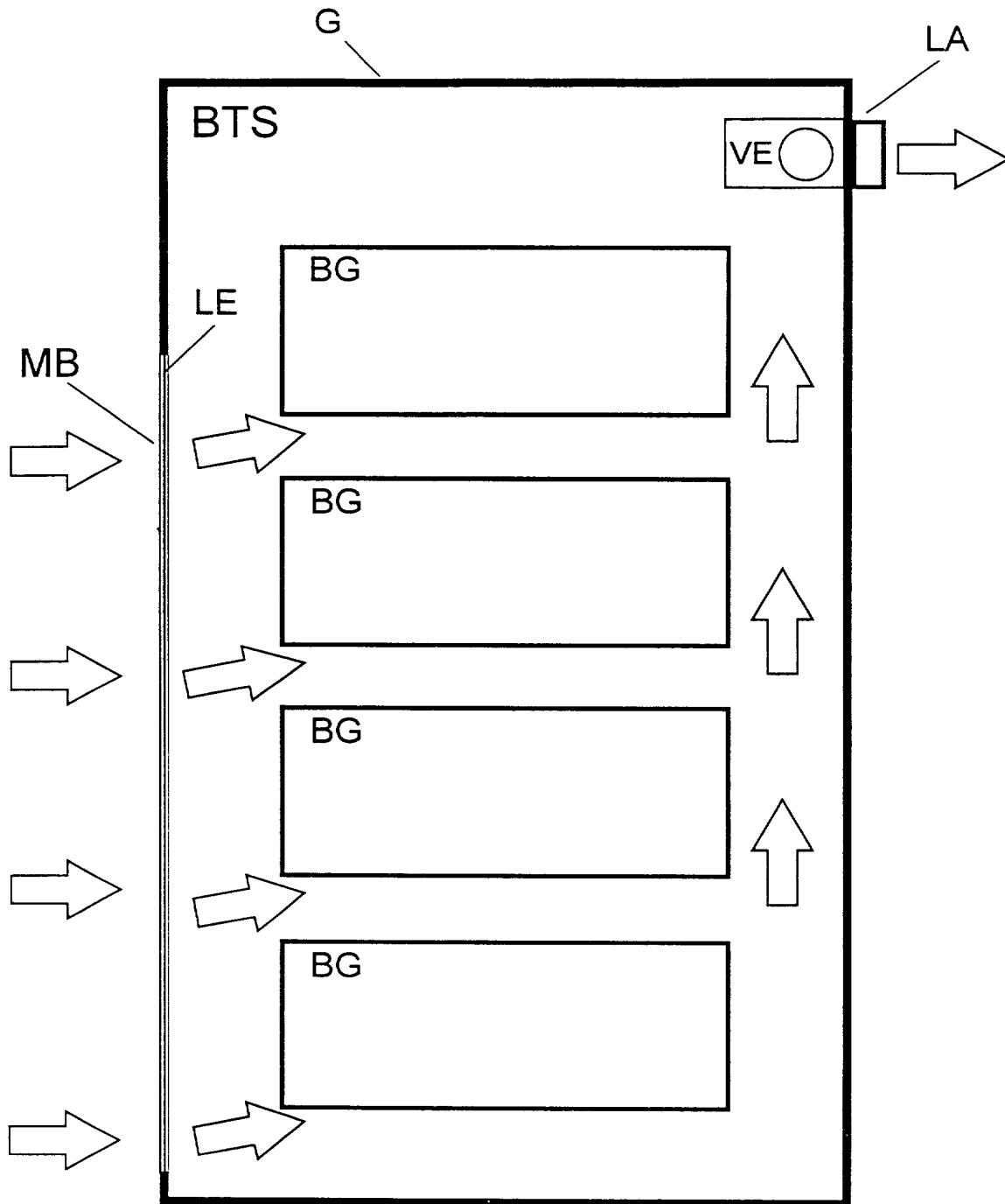
FIG 2



FRONT VIEW  
Vorderansicht

09581712.101600

FIG 3



Side View  
Seitenansicht

FIG 4

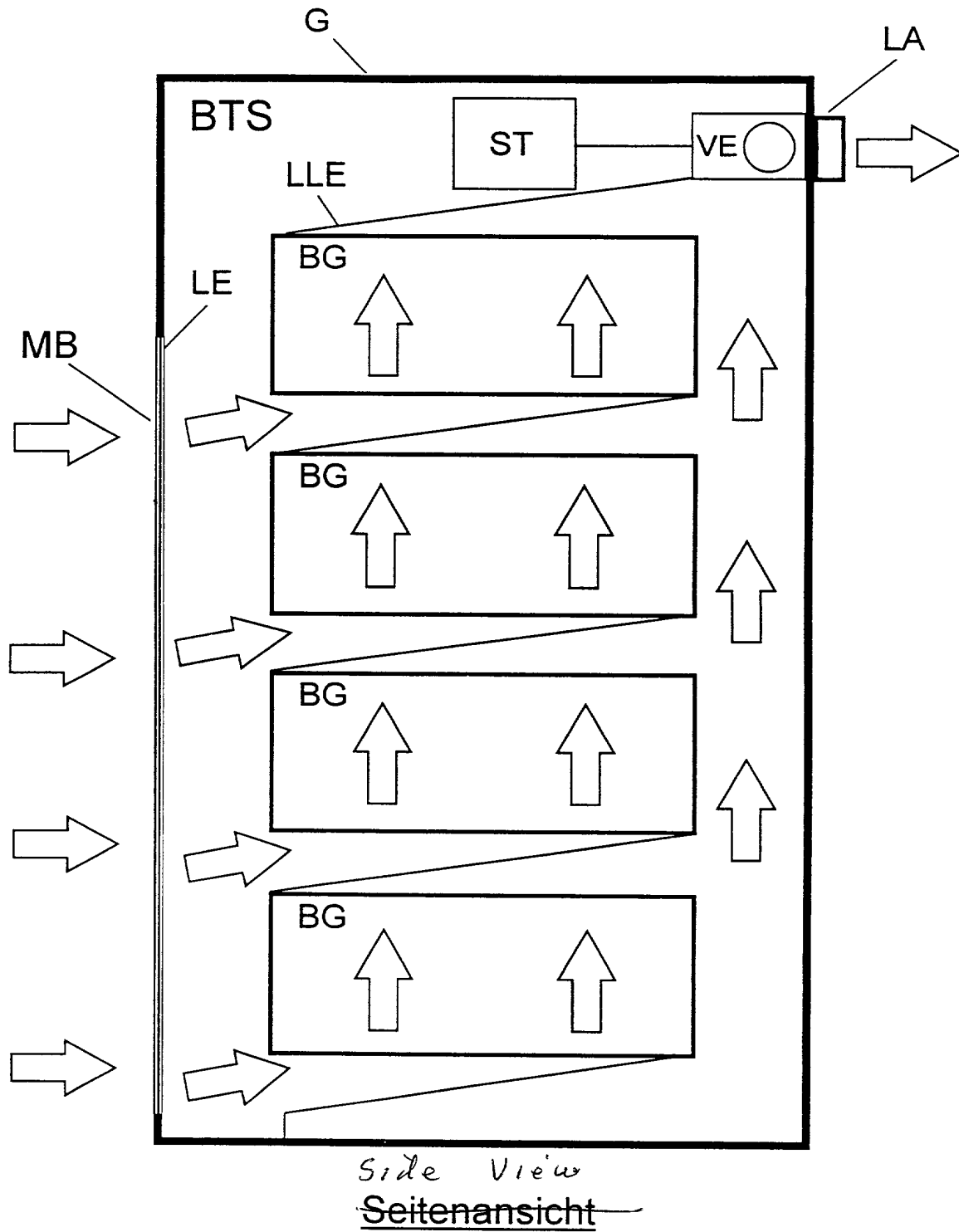
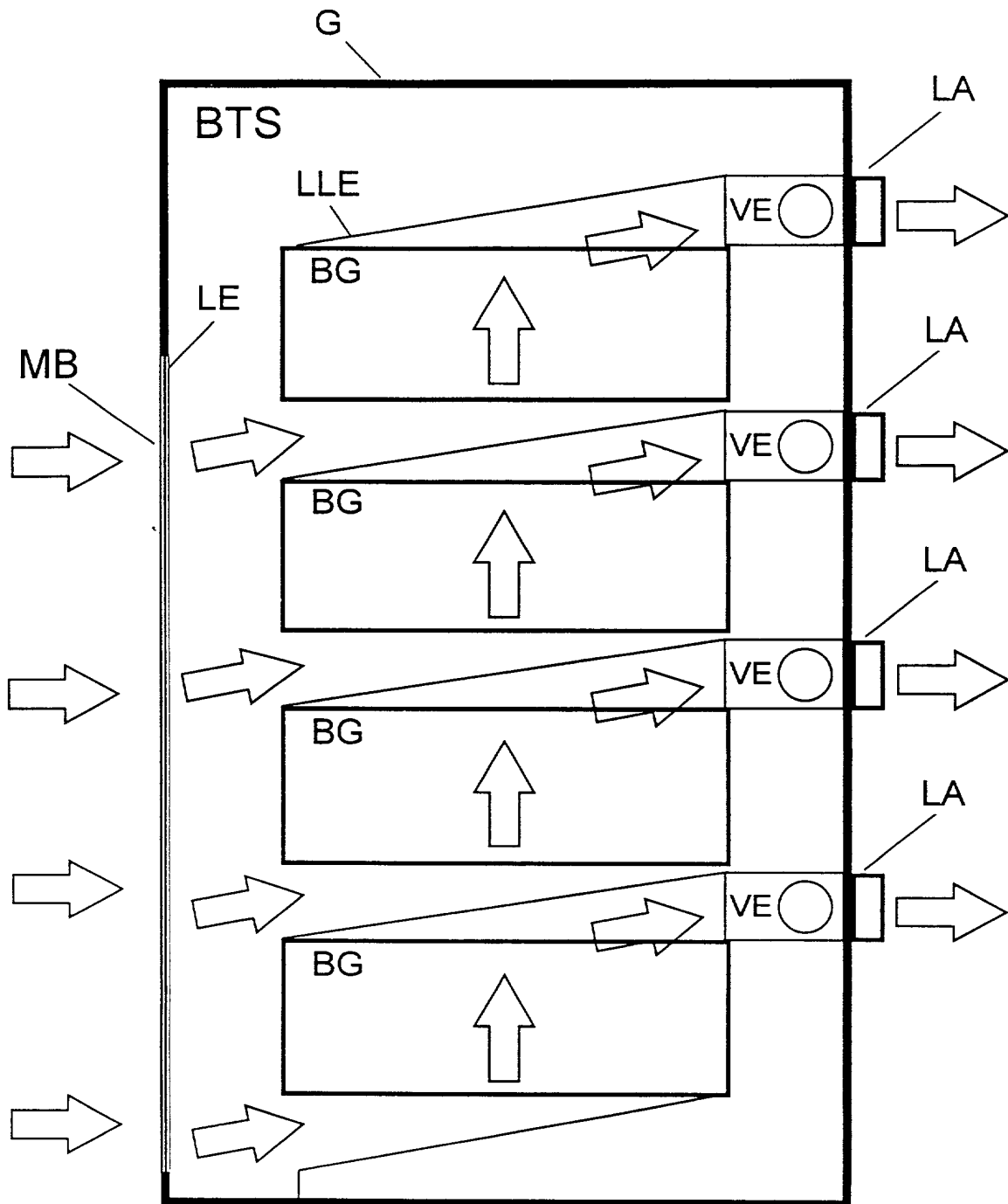


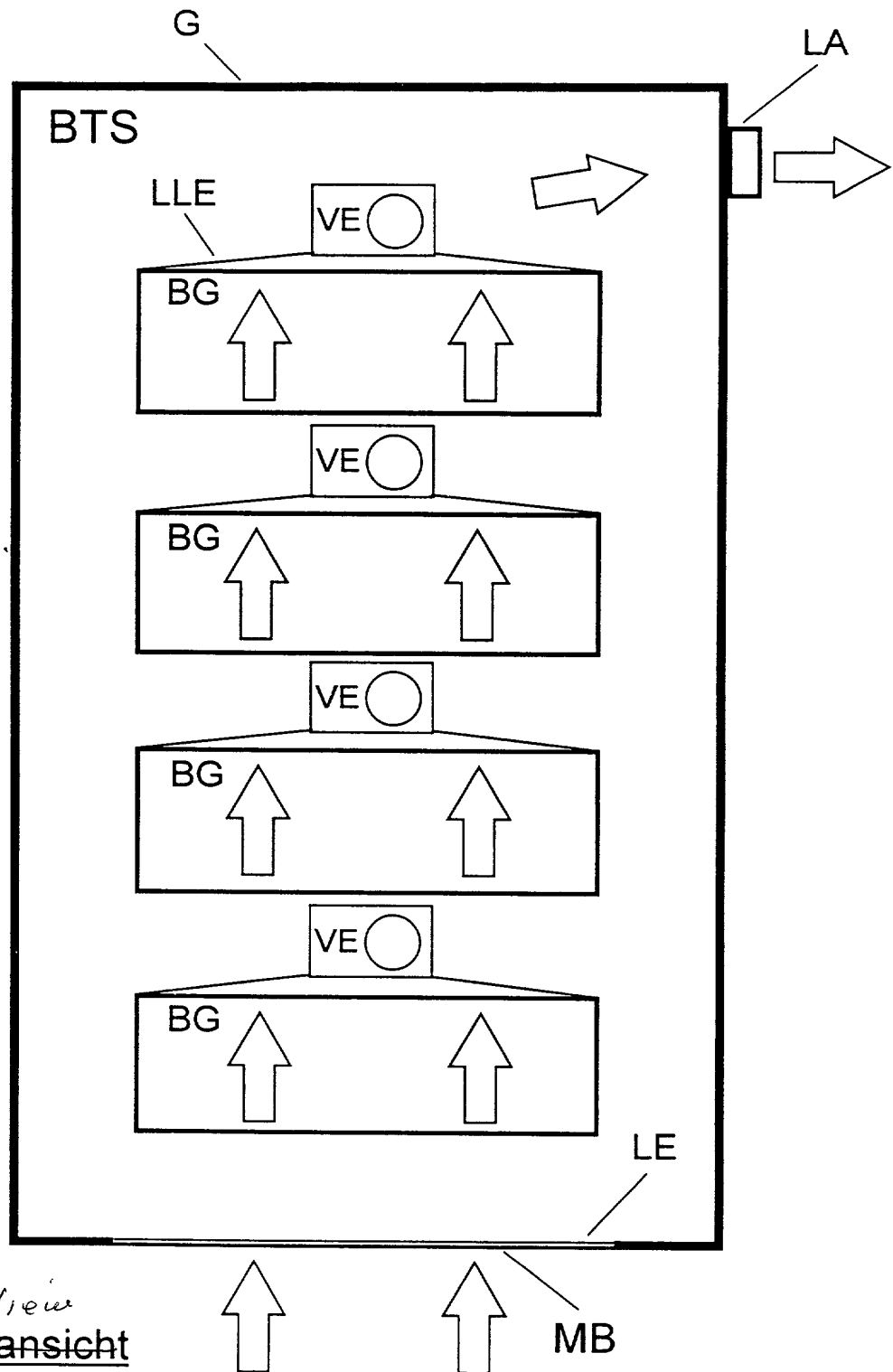


FIG 5



Side View  
Seitenansicht

FIG 6



**DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION**  
**ERKLÄRUNG FÜR PATENTANMELDUNGEN MIT VOLLMACHT**  
**German Language Declaration**

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für des dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

Anordnung zum Kühlen von elektrischen Baugruppen

deren Beschreibung

(zutreffendes ankreuzen)

☐ hier beigelegt ist.

☒ am 9 December 1998 als  
PCT internationale Anmeldung  
PCT Anmeldungsnummer PCT/DE98/03621  
eingereicht wurde und am \_\_\_\_\_  
abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56 von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

the specification of which

(check one)

☐ is attached hereto

☐ was filed on \_\_\_\_\_ as  
PCT international application  
PCT Application No. \_\_\_\_\_  
and was amended on \_\_\_\_\_  
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

## German Language Declaration

Prior foreign applications

Priorität beansprucht

Priority Claimed

197 55 944.1    Germany    16 December 1997  
(Number)        (Country)        (Day Month Year Filed)  
(Nummer)        (Land)            (Tag Monat Jahr eingereicht)

☒    ☐  
Yes    No  
Ja    Nein

\_\_\_\_\_  
(Number)        (Country)        (Day Month Year Filed)  
(Nummer)        (Land)            (Tag Monat Jahr eingereicht)

☐    ☐  
Yes    No  
Ja    Nein

\_\_\_\_\_  
(Number)        (Country)        (Day Month Year Filed)  
(Nummer)        (Land)            (Tag Monat Jahr eingereicht)

☐    ☐  
Yes    No  
Ja    Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56 meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122 I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

\_\_\_\_\_  
(Application Serial No.)  
(Anmeldeseriennummer)

\_\_\_\_\_  
(Filing Date)  
(Anmeldedatum)

\_\_\_\_\_  
(Status)  
(patentiert, anhängig,  
aufgegeben)

\_\_\_\_\_  
(Status)  
(patented, pending,  
abandoned)

\_\_\_\_\_  
(Application Serial No.)  
(Anmeldeseriennummer)

\_\_\_\_\_  
(Filing Date)  
(Anmeldedatum)

\_\_\_\_\_  
(Status)  
(patentiert, anhängig,  
aufgegeben)

\_\_\_\_\_  
(Status)  
(patented, pending,  
abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

# German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent- und Warenzeichenamt: (Name und Registrationsnummer anführen)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

And I hereby appoint Messrs.

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Staatsangehörigkeit		Citizenship	
Postanschrift		Post Office Address	

(Bitte entsprechende Informationen und Unterschriften im Falle von zweiten und weiteren Miterfindern angeben).

(Supply similar information and signature for second and subsequent joint inventors).

- 1 -

IN THE UNITED STATES ELECTED OFFICE OF  
THE UNITED STATES PATENT AND TRADEMARK OFFICE  
UNDER THE PATENT COOPERATION TREATY - CHAPTER II

CHANGE OF ADDRESS OF APPLICANT'S REPRESENTATIVE

5      APPLICANTS:      Guido Reeck, Bruno Hoefer and Alfred Gahse  
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         DOCKET NO.:      P-00,1260  
         SERIAL NO.:      09/581,712      EXAMINER:  
         FILING DATE:      ART UNIT:  
10      INTERNATIONAL APPLICATION NO.: PCT/DE98/03621  
         INTERNATIONAL FILING DATE: 9 December 1998  
         INVENTION: "DEVICE FOR COOLING ELECTRICAL SUBASSEMBLIES"

**BOX PCT**

15      Assistant Commissioner for Patents  
         Washington, D.C. 20231

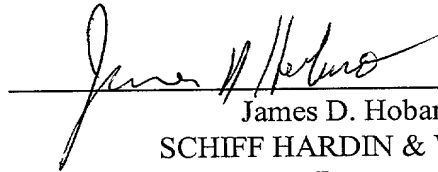
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20      Members of the Firm Hill & Simpson designated on the original Power of  
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10

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15 DATED: October 16, 2000